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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/941,963	08/28/2001	Sunfei Fang	01P14755 US	7736

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EXAMINER

LEE, HSIEN MING

ART UNIT	PAPER NUMBER
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2823

DATE MAILED: 11/13/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/941,963	Applicant(s) FANG, SUNFEI	
	Examiner Hsien-Ming Lee	Art Unit 2823	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1) ☒ Responsive to communication(s) filed on 25 August 2003.

2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.

3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4) ☒ Claim(s) 1-4,6-13,15-19 and 21-23 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5) ☐ Claim(s) _____ is/are allowed.

6) ☒ Claim(s) 1-4,6-13,15-19 and 21-23 is/are rejected.

7) ☒ Claim(s) 6 and 21 is/are objected to.

8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9) ☐ The specification is objected to by the Examiner.

10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. §§ 119 and 120

12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.

13) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application) since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.
a) ☐ The translation of the foreign language provisional application has been received.

14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121 since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

Attachment(s)

1) <input type="checkbox"/> Notice of References Cited (PTO-892)	4) <input type="checkbox"/> Interview Summary (PTO-413) Paper No(s). _____
2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)	5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)
3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____	6) <input type="checkbox"/> Other: _____

DETAILED ACTION

Remarks

1. Applicant's cancellation to claims 5, 14 and 20 is acknowledged.
2. Claims 1-4, 6-13, 15-19 and 21-23 are pending in the application.

Claim Objections

3. Claims 6 and 21 are objected to because of the following informalities: dependent from cancelled claims 5 and 20, respectively. In addition, the limitation "the plasma" in claims 6 and 21 lacks antecedent basis as result of canceling claims 5 and 20.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

5. Claims 1-4, 6-13, 15-19 and 21-23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chooi et al.(US 6,284,657) in view of applicants admitted prior art (hereinafter referred as "AAPA") and Yi et al. (US 5,900,163).

In re claims 1-3 and 10-12, Chooi et al. teach the claimed method of cleaning a hole 22/24 as shown in Fig. 1-13 and related text in an organic inter-level dielectric (ILD) 14 and 18 (e.g. fluorinated polymer, col.5, lines 33-44), the hole 22/24 having sidewalls and a bottom, the organic ILD 14 and 18 disposed on a semiconductor substrate 10, the method comprising: forming a plasma over the interconnect structure; performing a radio frequency (RF) plasma etching for cleaning the hole 22/24, wherein the plasma comprises a mixture of argon and

nitrogen (col. 6, lines 37-43), wherein a first component (argon) acts as physical sputter clean (etch), as evidenced by AAPA plasma comprises a mixture of argon and nitrogen (col. 6, lines 37-43), wherein a first component (argon) acts as physical sputter clean (etch), as evidenced by AAPA; and a second component (nitrogen) acts as ion enhanced organic etch or ion enhanced chemical etch; and further anisotropically removing organic material from bottom of the hole 22/24 with the chemical etch component (i.e. nitrogen).

Chooi et al do not expressly teach that the argon acts as sputter clean function. One of the ordinary skill in the art, however, would have recognized that the role of argon in the plasma functions as the sputter clean because argon has been widely used as etching gas in physical sputter cleaning practice, as evidenced by AAPA. In addition, Chooi et al. also inherently teach that nitrogen in the plasma functions as ion enhanced organic etch because nitrogen gas in the plasma would convert into ion species under RF power, wherein the ions are for etching purpose.

In re claims 4, 13 and 18, Chooi et al. in view of AAPA teach that the RF sputter clean comprises argon but fail to teach comprising helium. However, helium is art-recognized equivalence to argon in physical sputter cleaning (etching), as evidenced by Yi et al. (col. 1, lines 50-53).

Therefore, one of the ordinary skill in the art, at the time the invention was made, would have been motivated to substitute argon of Chooi et al. in view of AAPA with helium of Yi et al. for a reasonable expectation of success because both argon and helium are relatively heavy masses and are good candidates for physical sputtering.

In re claims 6, 8, and 21, Chooi et al. in view of AAPA teach that the RF sputter clean and the organic etch are performed at the same time interval by the same plasma because a

singular etching plasma comprising argon and nitrogen is used to treat the sidewall and bottom of the hole, as stated above.

In re claims 7 and 15, Chooi et al. teach that the organic etch is with the RF plasma but does not expressly suggest that the RF bias is of between about 0 watts and about 500. However, the selection of the RF bias power is obvious because it is a matter of determining optimum process condition by routine experimentation with a limited number of species. In re Jones, 162 USPQ 224 (CCPA 1955)(the selection of optimum ranges within prior art general conditions is obvious) and In re Boesch, 205 USPQ 215 (CCPA 1980)(discovery of optimum value of result effective variable in a known process is obvious). In such a situation, the applicant must show that the particular range is critical, generally by showing that the claimed range achieves unexpected results relative to the prior art range. See M.P.E.P. 2144.05, III. In fact, Yi et al. teach utilizing RF plasma etching, wherein the bias power is in the range of 0~300 watts (col. 6, lines 35-36). One of the ordinary skilled in the art would have been motivated to select a desired bias power to perform the cleaning, since the bias power is material dependent.

In re claim 9, Chooi et al. in view of AAPA et al. also teach that the hole 22/24 is part of an interconnect structure, wherein a conductive layer 10 is disposed at a bottom of hole 22/24 as shown in Fig. 2, wherein the sputter clean removes a surface oxide formed on the conductive layer 10.

In re claims 16, 17, 19, , it would have been obvious to one of the ordinary in the art to recognize that Chooi et al. in view of AAPA, as stated above, also teach the claimed method of forming an interconnect through an organic ILD, the method comprising:

- forming a lower conductive layer 10 on a semiconductor substrate;

- forming the organic ILD 14 and 18 on the lower conductive layer 10;
- etching a hole 22/24 through the organic ILD 14 and 18 down to the lower conductive layer 10 (Fig. 2);
- performing an RF sputter clean (using the argon gas) of a bottom of the hole 22/24;
- performing an anisotropic, ion enhanced chemical organic etch of the hole (i.e. using nitrogen gas), wherein the etch is performed at least partially during the RF sputter clean because a singular etching plasma comprising argon and nitrogen is used to treat the sidewall and bottom of the hole 22/24;
- forming a plug 22 in the hole 22/24 (Fig. 14); and
- forming an upper conductive layer 24 (via) on the organic ILD 18 and the plug 22 (Fig. 14)

In re claim 22, Chooi et al. in view of AAPA also teach forming a lower cap layer 12 on the lower conductive layer 10 before the forming of the organic ILD layer 14 and 18 (Fig. 1), and forming an upper cap layer 20 on the organic ILD layer 18 (Fig. 10), wherein the etching of the hole 22/24 further comprises etching through the upper cap layer 20 and the lower cap layer 12 (Fig. 11).

In re claim 23, Chooi et al. in view of AAPA also teach forming a liner 26 in the hole 22/24 before forming the plug 22 (Figs. 12-14).

Response to Arguments

6. Applicant's arguments filed 8/25/03 have been fully considered but they are not persuasive for the reasons as follow.

Firstly, applicant argues that “the Examiner does not use Yi et al. in rejecting independent claims 1, 10 and 16.” (second paragraph, page 6).

Contrary the argument, 1-4, 6-13, 15-19 and 21-23 are rejected in a combination of Chooi et al., applicants admitted prior art and Yi et al., as stated above. In particular, Yi reference is used to reject claims 4, 13 and 18 as stated above, which are dependent from independent claims 1, 10 and 16. Thus, the Examiner **does** use Yi et al. in rejecting independent claims 1, 10 and 16.

Secondly, in re the combination of Chooi et al. and AAPA, applicants argues that “none of the cited prior art, taken alone or in combination, teaches or suggests performing an anisotropic, ion enhanced organic etch at least partially during an R.F sputter clean.” (fourth paragraph, page 6).

To support the position, applicant further asserts that because: (1) AAPA “does not teach or suggest performing an anisotropic, ion enhanced organic etch at least partially during the RF sputter clean process” due to the fact that AAPA teaches performing an radio frequency (RF) sputter clean of the hole (fourth paragraph, page 6); and (2) “Chooi et al. never even address performing a cleaning process step on the trench or via, let alone disclose a sputter clean in combination with an anisotropic, ion enhanced organic etch” (last paragraph of page 6 through first paragraph of page 7) due to the fact that Chooi et al. teach an etch process for etching layer 15, not a cleaning process (line 7, page 7), not exposing organic layer or displaced organic material on layer 15 (line 9, page 7); and teach forming a pseudocarbon nitride layer, “completely unrelated to the sputter clean and organic etch of the claimed invention (third

paragraph, page 7); and combining unrelated processes from two separate embodiments (third paragraph, page 7).

In response to the argument with respect to AAPA teachings, AAPA is used to remedy the deficiency of Chooi et al. that Chooi et al. is **silent** as to the **function** of argon in the RF plasma being acting as physical sputter clean (i.e. etch) although Chooi et al does teach utilizing a plasma comprising argon and nitrogen (col. 6, lines 37-43) for etching or cleaning the hole. AAPA clearly teaches that the function of argon in the RF plasma acts as physical sputter clean, wherein the RF plasma is for cleaning purpose because **cleaning can be performed with a dry etch process**, such as RF sputtering plasma (second paragraph, page 2 in the specification). Thus, argon in Chooi's RF plasma **does** act as physical sputter clean, as evidenced by AAPA.

In response to the argument with respect to Chooi's teachings, it is submitted that Chooi et al **do** address performing a cleaning process step on the trench or via, let alone disclose a sputter clean in combination with an anisotropic, ion enhanced organic etch because:

(a) Chooi et al. teach a process for etching or cleaning the hole surrounded by a layer 15, i.e. simultaneously cleaning the hole while etching the layer 15 to form spacers 19 (from Fig. 5 to Fig.6), wherein the etching process acts as cleaning process, as evidenced by AAPA, in which AAPA teaches that **cleaning can be performed with a dry etch process**. In other word, the etching process in Chooi et al. acts as or broadly interprets as cleaning process. And this etching or cleaning process would anisotropically remove any organic material from the bottom of the hole, wherein the organic material comes from the residues resides at the **bottom** of an initial hole 22/24 or 22/25 (Fig.4) when the initial hole is formed by etching organic layers 14 and 18. The organic residues at the bottom of the hole would reveal when etching or cleaning the hole to

expose the bottom of the hole (Figs. 5-6); and the organic residues are removed while performing the etching or cleaning.

(b) Chooi et al. teach performing sputter clean and organic etch with reference to Figs. 1-13 and related text as stated above, **not Figs. 16-20** wherein the pseudocarbon nitride layer is formed. The Examiner believes that the argument may arise from the text on col. 9, lines 48-49 in Chooi et al. that was referred by the Examiner in the previous Office Action, page 2. However, the argument has been resolved by restating why the limitations as recited in claims 7 and 15 are obvious to the ordinary skilled in the art, as stated in this Office Action.

Thirdly, applicant argues that there is no motivation to combine Chooi et al and AAPA.
(second paragraph, page 8)

In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). In fact, the motivation for combining has been established in the previous Action and again explained in this Action as well, as stated above.

Lastly, regarding the arguments stated on pages 9-13, they have been explained previously.

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Hsien-Ming Lee whose telephone number is 703-305-7341. The examiner can normally be reached on M-F (9:00 ~ 5:00).

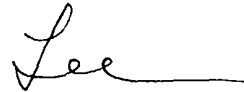
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If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on 703-306-2794. The fax phone number for the organization where this application or proceeding is assigned is 703-308-7382.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

Hsien-Ming Lee
Examiner
Art Unit 2823

A handwritten signature in black ink, appearing to read 'Lee', with a long horizontal stroke extending to the right.

Nov. 8, 2003